

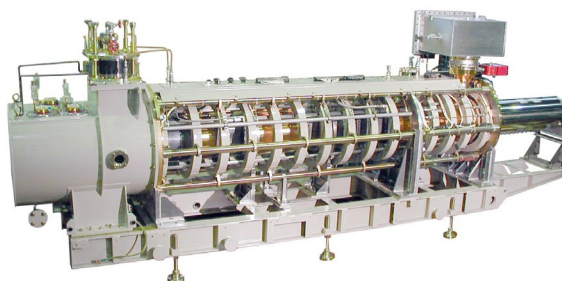
# TENTATIVE

## PULSED KLYSTRON AMPLIFIER E3740A

TOSHIBA E3740A is a high power pulsed amplifier klystron designed for RF source in particle accelerator. The E3740A delivers 3MW at 324MHz with 55% of efficiency and more than 50dB of a power gain. It is designed to carry out pulse operation when anode voltage is impressed to a modulating anode with 620μs of RF pulse width and 50 pps of pulse repetition rate.

RF input connector is a type-N coaxial and output is a WR2300 waveguide flange. VT-68928A for the electromagnet, VT-65131A for the stand, VT-21048B for the oil tank are respectively available. They can be easily installed by their integrated configuration. Electron Gun is oil-cooled, collector, body, electromagnet, and oil tank are respectively water-cooled. Output window is air-cooled.

A dispenser cathode promises high reliability and long tube life.



### General Characteristics

Electrical <sup>(2)</sup>	Symbol	Min		Max	Units
Frequency	f <sub>o</sub>	--	324	--	MHz
Heater current	I <sub>f</sub>	--		26	A
Heater voltage	E <sub>f</sub>	9		15	V
Heater warm-up time	t <sub>k</sub>	60		--	min
Peak beam voltage	e <sub>pyb</sub>	70	102	110	kV
Peak anode voltage	e <sub>pya</sub>	--	87.2	—	kV
Anode voltage dividing ratio <sup>(10)</sup>	e <sub>pyb</sub> :e <sub>pya</sub>	90	100	110	%
Anode bias voltage	E <sub>akb</sub>	-3		-2	kV
Beam perveance <sup>(11)</sup>	G	1.27	1.37	1.47	a/v <sup>3/2</sup>
Peak beam current	i <sub>k</sub>	--	44.6	--	a
Peak anode current	i <sub>a</sub>	--		15	ma
Peak drive power	p <sub>d</sub>	--	25	30	w
Peak output power	p <sub>o</sub>	0.5	2.5	3	MW
Efficiency <sup>(8)</sup>	η	55		--	%
Gain <sup>(8)</sup>	G <sub>p</sub>	50		--	dB
Pulse width(beam)	tp(e <sub>pya</sub> )	--		700	μs
Pulse width(rf)	tp(rf)	--	620	650	μs

\*The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA ELECTRON TUBES & DEVICES CO., LTD. (TETD) for any infringements of patents or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of TETD or others.

\*The information contained herein may be changed without prior notice. It is therefore advisable to contact TETD before proceeding with the design of equipment incorporating this product.

	Symbol	Min	Max	Units
Pulse repetition	prr	--	50	pps
Load VSWR	$\sigma L$	--	1.2	
Ground		body		
Ion pump voltage	Eion	3.2	3.5	3.8 kV
Electromagnet current 1	Isol1	--	16.0	20.0 A
Electromagnet current 2	Isol2	--	16.0	20.0 A
Electromagnet current 3	Isol3	--	16.0	20.0 A
Electromagnet voltage 1	Esol1	--	20.0	V
Electromagnet voltage 2	Esol2	--	375.0	V
Electromagnet voltage 3	Esol3	--	94.0	V

Mechanical	Symbol	Min	Max	Units
Dimension		See outline drawing		
Length		Approx.5040(after assembly)		
Klystron		Approx.4527		
Electromagnet-Stand		Approx.4595		
Oil tank		Approx.915		
Weight		Approx.2900(after assembly)		
Klystron(with lead at body)		Approx.730		
Electromagnet /Stand		Approx.1550		
Oil tank		Approx.320		
Insulating oil		Approx.300		
Lifting attachment(not included in total weight)		Approx.260		
Mounting Position		Horizontal, Output window up		
Ion pump		1-8l/s(with permanent magnet)		
X-ray shield <sup>(5)</sup>		Required		
Connector and flange				
RF Input connector		Coaxial, Type N		
RF Output flange		WR2300		
Heater terminal		Model D-117-BA(Isolation Products)		
Heater/cathode terminal		Model D-117-BA(Isolation Products)		
Anode terminal		Model D-117-BA(Isolation Products)		
Ion pump terminal		HV coaxial connector (SHV-R male)		
Klystron temperature monitor terminal		MS type connector (MS3102A-18-19S)		
Body coolant temperature monitor		2CH(In-Out: T-type thermo couple)		
Collector temperature monitor		2CH(beam edge , point:type thermocouple)		
Output window temperature monitor		1CH(Cu sleeve :T-type thermocouple)		
Electromagnet current feed through		MS connector (MS3102A-24-10P)		
		3CH(sol1,sol2,sol3)		
Electromagnet temperature monitor terminal		MS connector (MS3102A-18-19P)		
		5CH(T-type thermocouple)		

## Cooling

Electron Gun; Oil cooling

Body; Water cooling

Flow rate	Qwb	20	--	l/min
Pressure drop	$\Delta P_{wb}$	--	0.39	MPa
Water pressure	Pw	--	0.78	MPa
Water inlet temperature <sup>(7)</sup>	Twin	4	35	°C
Water connector(In)		SPcoupler4P		
Water connector(Out)		SPcoupler4S		

Collector; water cooling

Flow rate	Qwc	150	--	l/min
Pressure drop	$\Delta P_{wc}$	--	0.39	MPa
Water pressure	Pw	--	0.78	MPa
Water inlet temperature <sup>(7)</sup>	Twin	4	35	°C
Inlet coolant connector		lever lock coupler 1-1/4"(plug)		
Outlet coolant connector		lever lock coupler 1-1/4"(plug)		

Output window coaxial waveguide converter inner conductor; air cooling

Air flow	Qawg	100	--	l/min
Water connector(In)		φ51 pipe		

Electromagnet(sol1) ; Oil cooled

Electromagnet(sol2,sol3) · Oil tank; water cooling<sup>(9)</sup>

Flow rate	Qws	10	--	l/min
Pressure drop	$\Delta P_{ws}$	--	0.39	MPa
Water pressure	Pw	--	0.78	MPa
Inlet water temperature <sup>(7)</sup>	Twin	4	35	°C
Inlet coolant connector		SPcoupler3P		
Outlet coolant connector		SPcoupler3S		

Absolute Ratings<sup>(2)(3)</sup>

	Symbol	Min	Max	Units
Frequency	f <sub>0</sub>	323.9	324.1	MHz
Heater current	I <sub>f</sub>	--	26	A
Heater surge current	I <sub>f</sub> (surge)	--	45	A
Heater warm-up time	t <sub>k</sub>	60	--	min
Peak beam voltage	e <sub>pyb</sub>	--	110	kV
Peak anode voltage	e <sub>pya</sub>	--	100	kV
Anode bias voltage	E <sub>akb</sub>	-3	-2	kV
Body-anode voltage <sup>(4)</sup>	E <sub>ab</sub>	--	113	kV
Peak beam current	i <sub>k</sub>	--	60	a
Peak anode current	i <sub>a</sub>	--	20	ma
Peak drive power <sup>(6)</sup>	p <sub>d</sub>	--	100	W
Peak output power	p <sub>o</sub>	--	3	MW
Average output power	P <sub>o</sub>	--	93	kW
Average body dissipation power	P <sub>bod</sub>	--	10	kW

Collector dissipation power	Pcol	--	242	kW
Pulse width (beam)	tp(epy)	--	700	μs
	Symbol	Min	Max	Units
Pulse width (rf)	tp(rf)	--	650	μs
Pulse repetition	pr	--	50	pps
Load VSWR	σL	--	1.4	
Electromagnet current				
Sol1	Isol1	--	20.0	A
Sol2	Isol2	--	20.0	A
Sol3	Isol3	--	20.0	A
Electromagnet voltage				
Sol1	Esol1	--	20.0	V
Sol2	Esol2	--	375.0	V
Sol3	Esol3	--	94.0	V
Ion pump voltage	Eion	3.2	3.8	kV
Inlet coolant pressure				
Body	Pw	--	0.98	MPa
Collector	Pw	--	0.98	MPa
Electromagnet/ Oil tank	Pw	--	0.98	Mpa
Waveguide pressure	Pwg	--	19.6	kPa
Oil tank pressure	Pot	--	19.6	kPa
Inlet coolant flow				
Body	Qwb	20	--	l/min
Collector	Qwc	150	--	l/min
Electromagnet/ Oil tank	Qws	10	--	l/min
Output window/waveguide cooling air flow	Qawg	100	--	l/min
Temperature				
Inlet cooling water temperature <sup>(7)</sup>	Twin	4	35	°C
Inlet cooling air temperature <sup>(7)</sup>	Tain	4	35	°C
Internal oil tank temperature <sup>(7)</sup>	Tot	25	40	°C

### TYPICAL OPERATION <sup>(2)</sup>

	OPR 1	OPR2	OPR3	
Frequency	324	324	324	MHz
Peak beam voltage	110.0	104.0	97.5	kV
Peak anode voltage	86.7	81.9	76.3	kV
Peak beam current	47.8	43.5	39.8	A
Peak output power	3.00	2.53	2.00	W
Peak drive power	9.3	10.2	11.2	W
Efficiency	57.0	56.0	51.4	%
Gain	55.1	53.9	52.5	dB

Note (1) The values in this data indicate the typical operation, size and shape of fit of klystron. The final vales should provide in an approval drawing and specifications.

(2) All voltages except heater voltage, ion pump voltage (body ground), peak body anode voltage, and anode bias voltage are referenced to the cathode. The ground is the klystron body. Pulse modulation system is anode pulse. Small letter “v” and “a” are the units in pulse operation, and indicate pulse voltage and pulse current, respectively.

(3) Referring to paragraph 6.5 of MIL-E-1G, those values are based on the “absolute system” and should not be exceed under continuous or transient condition. A single rating may be the limitation and simultaneous operation at another rating may not be possible. Design values for systems should include a safety factor to maintain operation within ratings under voltage and environmental variations. Interlocks should be provided in case vary from the absolute ratings. A performance cannot be guaranteed under operation departing from absolute ratings.

(4) Anode electrode and body electrode are negative and positive, respectively.

(5) The 6 mm thick lead shield outside the collector jacket, and 3 mm thick lead shield at the body part (at a drift and near an electron gun) are attached with this klystron. By using with the exclusive X-ray cage (option), it is possible to suppress X-ray intensity lower than  $20\mu\text{Sv/h}$  at a distance of 1m away from tube axis of klystron equipment. However, this value may be exceeded in the following places structurally. In this case, it is possible to get above-mentioned value by using a lead with 5 mm thick or more.

1.The waveguide from the X-ray shield cage.

2.The gap between the electromagnet and the X ray cage (mainly electron gun side)

The above-mentioned value does not mean harmless X ray intensity to human body, and does not guarantee of X-ray intensity radiated from equipment using the klystron. Provide a required X ray defense measure after reading the safety precautions and warnings.

(6) The tube shall not be damaged while driving at the Absolute Ratings without a beam voltage. Do not operate with the drive power more than saturated drive power on this beam voltage.

(7) Free from freezing and condensation.

(8) This is the characteristic at the saturated output in 2.5MW~2.55MW.

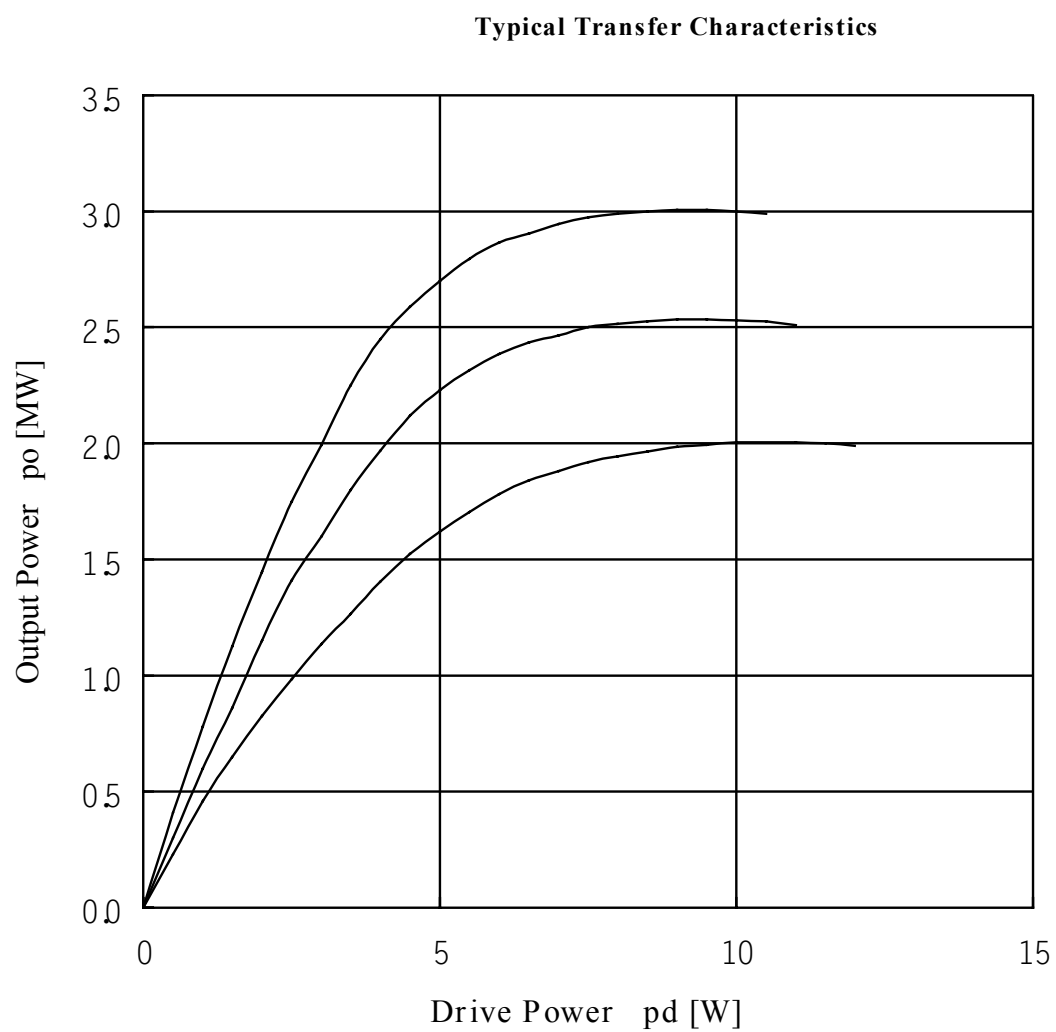
(9) The cooling circuit of an oil tank is a single system connected to the cooling circuit of an electromagnet in series.

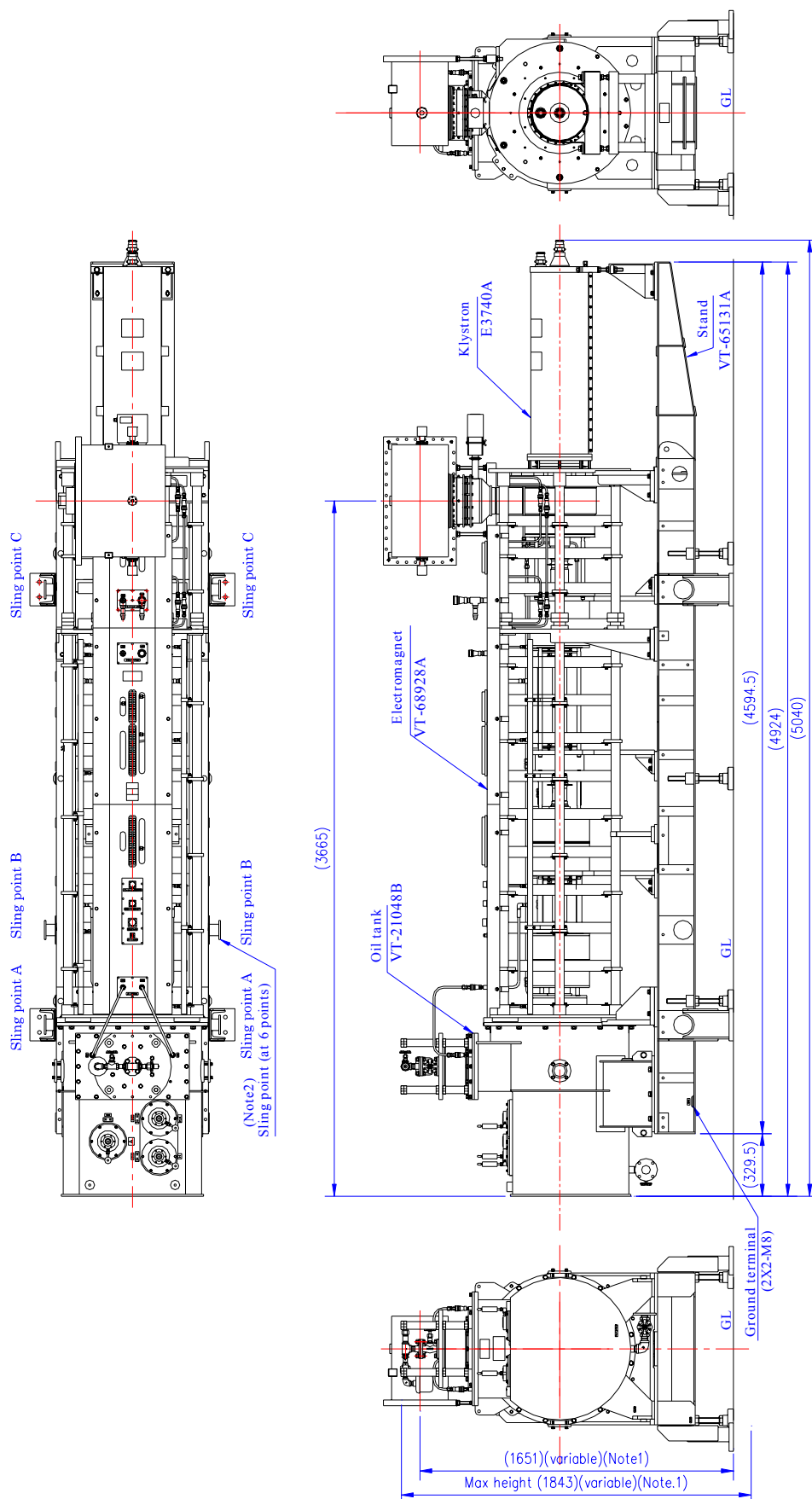
(10) The dividing ratio shows 100% when peak beam voltage and peak anode voltage is 110:94.

(11) This shows when the dividing ratio of peak beam voltage and peak anode voltage is 110:94(100%).

Accessories (necessary, but not delivered with the tube)

X-ray shield cage		VT-69393	1 set
Ion pump source	2 Output EIA standard rack type	VT-69085	1 set
	1 Output portable type	VT-69060	1 set
Oil tank detachable rail		VT-65131-2	1 set
Oil fill/drain hose		VT-61166-1	1 set
Oil fill reservoir tank		VT-21048-3	1 set
Klystron equipment movable stand		VT-65131-7	1 set
Lifting attachment		VT-65131-1	1 set





(Note.1) Variable range with level adjuster must be  $\pm 50$ mm.

(Note.2) For klystron transferring or setting, use a crane with sling kit VT-65131.

Sling must be mounted the following 4 positions.

For lifting sling kit, use a rope with 3.5t withstand load.

(1) Use sling point A and C with insulation oil.

(2) Use sling point B and C without insulation oil.

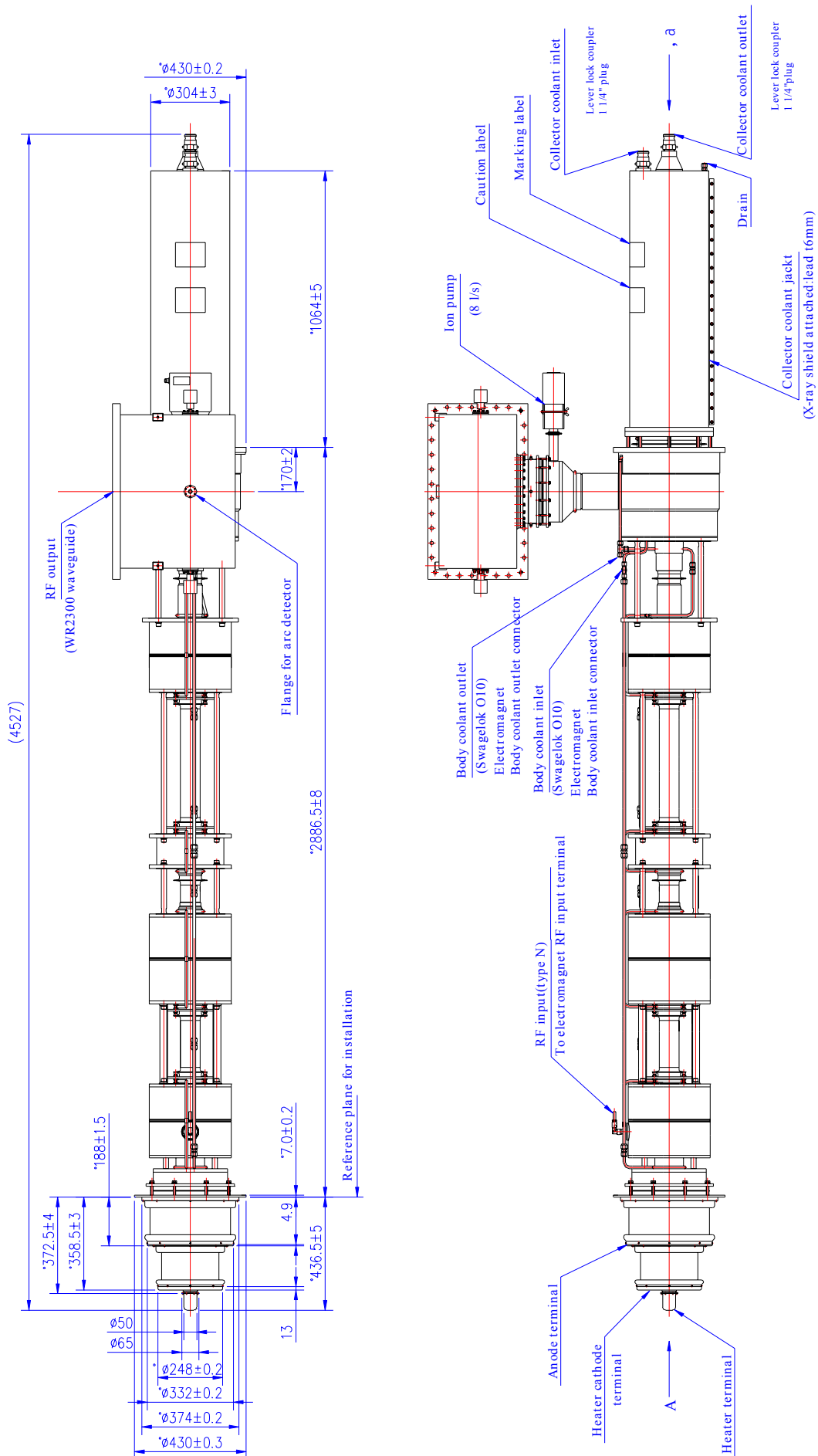
For transferring the klystron, use the carrier VT-65131-6(option).

(Note.3) Klystron installing position is determined by reference to waveguide while lifting klystron by crane, setting with level adjuster.

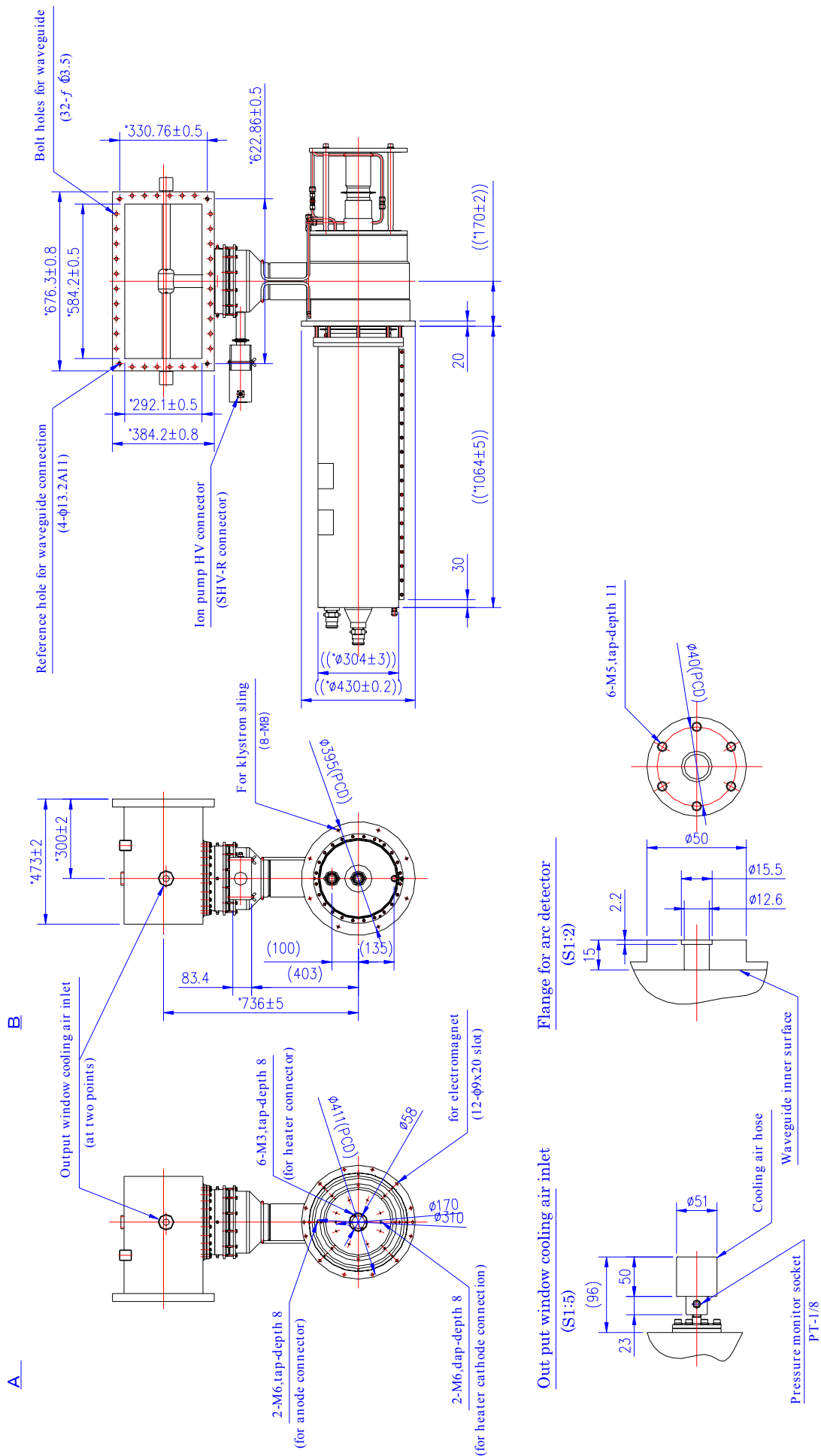
Gradient angle of Klystron must be within  $\pm 5\%$  at maximum.

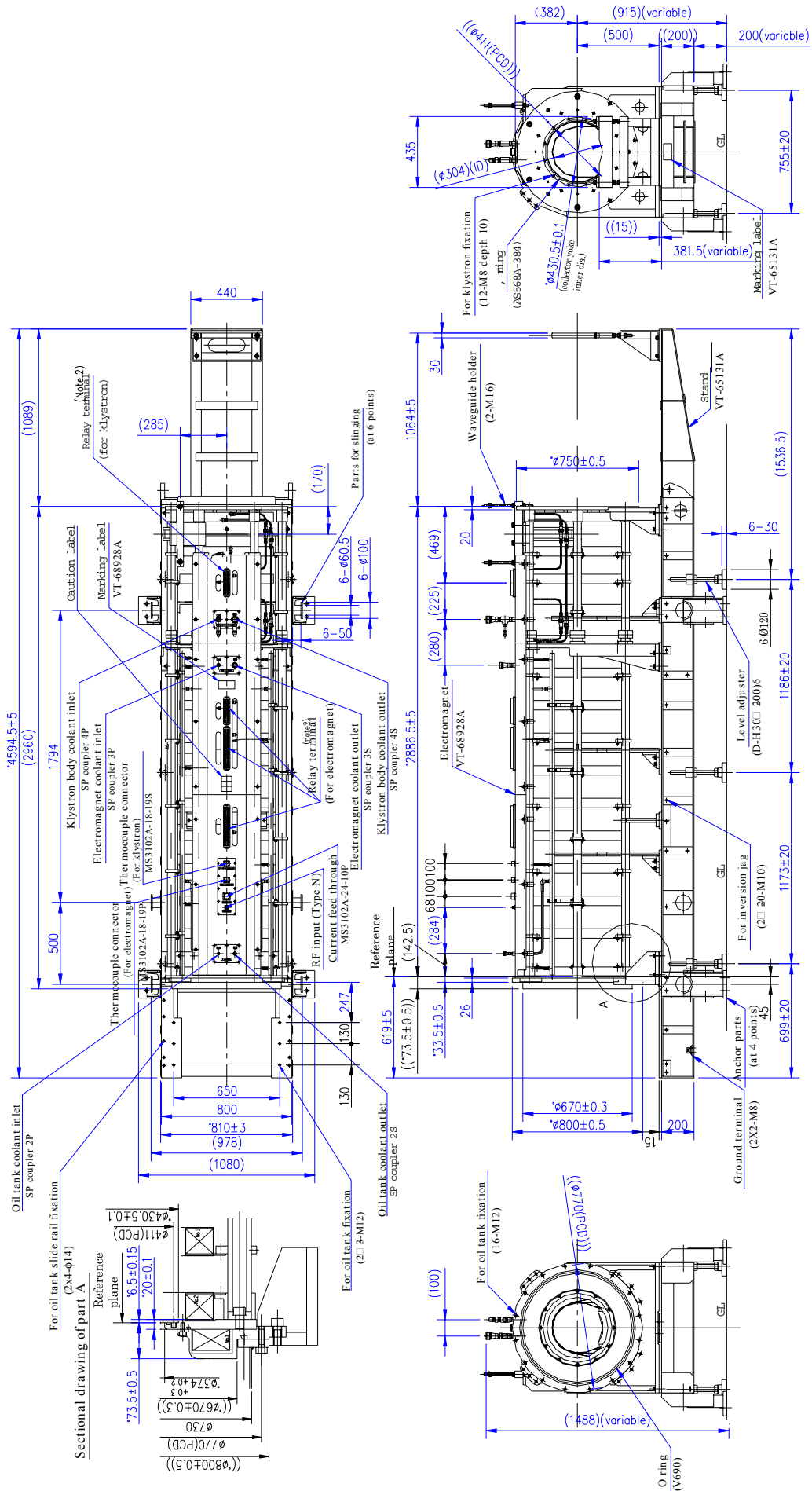
(Note.4) After the installing, anchor with klystron stand by furnished accessories.

Note that this klystron doesn't include anchor bolts.









(Note. 1) Indicate the variable range of thermal expansion absorption mechanism.

With insulation oil in tank, temperature range of the oil tank must be between 25 °C and 40 °C

In case the range could exceed, insulation oil must be removed in advance.  
(Note.2) Use the reservoir tank VT-21048-3(option) and the hose VT-61166-1 for pouring oil to the oil tank.

(Note.2) Use the reservoir tank VT-21048-3(option) and the hose VT-61166-1 for pouring oil to the oil tank.

## Notes (Operation)

- (1) Read and follow the instruction manuals. Take a special notice as below.
- (2) Referring to paragraph 6.5 of MILL-E-1G, those values are based on the “absolute system” and should not be exceeded under continuous or transient conditions. A single rating may be the limitation and simultaneous operation at another rating may not be possible. Design values for systems should include a safety factor to maintain operation within ratings under environmental variations.
- (3) The ion pump operates at +3500 +/- 300 Vdc. Ion pump supply should be operated all the time except in unavoidable situation. Interlock should be provided to prevent application of beam voltage, unless the ion pump current is less than specified value.
- (4) Don't give a shock more than 2G to the klystron. Keep the electric gun and the output ceramic clean.
- (5) Insert the klystron into the electromagnet, fix the klystron with the proper screws equally and tightly. Put the exclusive waveguide iris flange between the output flange and load waveguide flange. Don't put any dust into the waveguide.
- (6) Connect the pole piece and electromagnets steadily to the indicated places using the specified wire. Use over 22mm<sup>2</sup> diameter wire as a grounding wire.
- (7) Operation procedure of the klystron and electromagnet;  
See the labeled value of klystron as a specified value.  
\*Start
  - (a) Check the all connections (electrical and mechanical).
  - (b) Check the interlocks in the system.
  - (c) Check the ion pump current is less than specified value.
  - (d) Let the cooling water flow /air specified value to the klystron and electromagnet.
  - (e) When heater power is applied to a cold tube, the heater current shall be adjusted to prescribed value. This value of heater voltage shall be maintained for at least 60 minutes prior to the application of beam voltage.
  - (f) Set electromagnet current to the prescribed value.
  - (g) Turn on the beam voltage epyb to the prescribed value.
  - (h) In case of condensation of inside the waveguide, power drive must be gradually increased.  
\*Shut off
  - (a) Stop the system in a manner of inverse procedure to the start procedure described above.
  - (b) Keep the cooling water/air flow of the klystron and electromagnet for at least 10 minutes after the beam shut-off.
- (8) Use the specially designed packing case and cushions when keeping and carrying.
- (9) Operation environments  
Installation place: Indoor (No dirt floor)  
Ambient Temperature: 4~35°C (No condensation)  
Ambient Humidity: within 95% (No condensation)  
Coolant Temperature: 4~60°C (No freezing)

### Notes (System Design)

(1) Interlocks should be provided to prevent application of the beam voltage for the klystron protection. Provide adequate interlocks referring to Table 1.

Table 1

No	Characteristics		Abnormal state	Interlock level*1	Shut off speed*5	Shut off mode
1	Oil level		Under	Specified level	--	--
2	Heater current		Under	95% of labeled value*2	50ms	II
3	Heater current		Over	Absolute ratings or 105% of labeled value*2	50ms	
4	Heater current		Over	If(surge) Absolute ratings	50ms	III
5	Heater voltage		Under	90% of operating value	50ms	II
6	Heater voltage		Over	110% of operating value	50ms	III
7	Heater pre heating		Under	Specified time	—	—
8	Beam voltage		Over	Absolute ratings or 110% of operating value	20ms *3	II
9	Beam current		Over	Absolute ratings or 110% of operating value	*4	I
10	Anode current		Over	Absolute ratings or 200% of operating value	20ms *3	II
11	Beam pulse width		Over	Absolute ratings	20ms *3	II
12	Load VSWR		Over	Absolute ratings	10μs	IV
13	Loaded waveguide arc		Arcing	Arcing	10μs	IV
14	Klystron vacuum		Higher(ion pump current)	Operating value+0.5μ~1 μ A or 2 μ A	20ms *3	II
15	Electromagnet current		Under	95% of labeled value*2	50ms	II
16	Electromagnet current		Over	Absolute ratings or 105% or labeled value*2	50ms	V
17	Electromagnet voltage		Under	90% of operating value	50ms	II
18	Electromagnet voltage		Over	Absolute ratings or 110% of operating value	50ms	V
19	Coolant	Collector	Under	Absolute ratings or 90% of operating value	50ms	II
		Body				II
		Electromagnet				V
20	Temperature	Collector	Over	Tin+100℃ (beam edge,point)	50ms	II
		Body outlet		Tin+[equiv. absolute body dissipation temperature] ℃		II
		Output window		Tin+10℃ (sleeve)		IV
		Electromagnet		100℃ (No.1~No.5)		V

Shut off mode:

Mode I : Crowbar switch Fire⇒Anode power supply OFF⇒Beam power supply OFF

Mode II : Anode power supply OFF⇒Beam power supply OFF

Mode III : Anode power supply OFF ⇒ Beam power supply OFF ⇒Heater power supply OFF

Mode I : Drive power supply OFF⇒Anode power supply OFF⇒Beam power supply OFF

Mode V : Anode power supply OFF⇒Beam power supply OFF⇒Electromagnet power supply OFF

Note:

\*1 When interlock level is written with "or", set up in the severer one of conditions.

\*2 Indicated in the inspection sheet on klystron.

\*3 Intercept, before the following pulse comes.

\*4 Computed from 24J of inlet energy.

\*5 Shut off speed means the time until the first shut off mode after occurring the unusual situation.




Subsequent shut off mode should be completed as promptly as possible (target : less than 50ms).

- (2) A constant current alternator (1% or less of current variation tolerance) should be used as a heater fundamentally.  
However, when influence of a heater ham cannot be disregarded, use a constant direct current power supply.  
In this case, a cathode heater electrode is connected to positive and a heater electrode is connected to negative.  
In case not using a constant current supply, the heater current should not exceed a heater surge current. Interlocks should be provided to prevent the application of beam voltage during the heater warm-up time.
- (3) Use a constant current supply (1% or less of current variation tolerance) for an electromagnet source.
- (4) A high-voltage coaxial cable (RG-220/U) should be used for the connection cable of a high-voltage portion.
- (5) Attach resistance of 100-1000k $\Omega$  between a source and an anode electrode.
- (6) When anode voltage is supplied by the resistance voltage dividing system, the dividing ratio of the cathode voltage  $e_{pyb}$  and the anode voltage  $e_{pya}$  applied to a klystron sets to  $e_{pyb}:e_{pya}=110:94$  by standard setup, and makes 100% the dividing ratio at this time. Anode voltage can be adjusted at the range of dividing ratio in 100 $\pm$ 10% or more. Pay special attention to anode bias voltage at the time of a power-supply-circuit design.
- (7) Don't apply over power to RF input connector, RF output flange, the cooling-water entrance, and the inlet of the cooling air of the klystron equipment. A flexible type wiring and piping should be used for the connection to the peripheral, and support its load other than the klystron device.
- (8) Attach a circulator or an isolator between a klystron and load so that a load VSWR should not exceed an absolute rating.
- (9) In order to detect the arc discharge within a loaded waveguide, prepare an arc detector.
- (10) De-ionized water shall be used as coolant water.
- (11) Pure dry air shall be used as coolant air. When you ventilate using a blower, eliminate dust and humidity by attaching an air filter between the blower and the klystron.
- (12) Fixing of klystron equipment should use anchoring fixed attachments provided (four places). Each attachment has two  $\phi 20$  holes for anchor. Install the klystron using suitable anchor bolts adjusting the floor surface.

## SAFETY PRECAUTIONS AND WARNINGS

This operation manual describes important information for preventing injury to users, personnel at manufactures employing this electron tube, and other personnel, as well as for preventing property loss and ensuring safe operation. Fully understand the meanings of the following indications and symbols before reading this manual and observe all precautions to ensure safe operation.

### [Description of indications]

Indication	Meaning
 <b>DANGER:</b>	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
 <b>WARNING:</b>	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
 <b>CAUTION:</b>	Indicates a potentially hazardous situation which, if not avoided may result in minor or moderate injury or extensive property damage (e.g. damage to machinery, units, and accessories or occurrence of a fire).

This electron tube is intended and designed for use in combination with amplifier for industrial devices and scientific equipment.

If this electron tube is to be used with equipment other than the above, contact Toshiba Electron Tubes & Devices Co., Ltd. (TETD) in advance. TETD will not be held responsible for malfunction or damage caused by the use of this electron tube in applications other than those specified without prior approval.




When designing or operating equipment employing the electron tube, do not attempt to modify the electron tube and do not allow the electron tube to be operated beyond its ratings. TETD will not be held liable if these precautions are not observed.

**[Warning labels ]**


- |  |
|--|
| <p>(1) Warning labels as described in the operation manual are attached to this electron tube. Confirm that they are attached correctly before operating the electron tube.<br/>If incorrectly attached or missing labels are found, Contact Toshiba Electron Tubes &amp; Devices Co., Ltd..</p> <p>(2) Read all the labels and fully understand their meanings to ensure safe operation of the electron tube.</p> <p>(3) Maintain the labels so that they can be seen easily. Do not remove any labels or allow them to become dirty, covered, or otherwise obscured.</p> |
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**[Manufacturing equipment, warning indications for equipment, use of the electron tube]**






- |  |
|--|
| <p>(1) All equipment incorporating this electron tube must be equipped with safety mechanisms as described below.</p> <p>(2) All equipment incorporating this electron tube and their operations manual must include the warning indications described below to ensure safe operation of the electron tube.</p> <p>(3) To ensure safe operation of this electron tube, observe the precautions described below.</p> <p>(4) For any questionable points, consult with Toshiba Electron Tubes &amp; Devices Co., Ltd. before operating this electron tube.</p> |
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 <b>DANGER</b>	
  <b>(High voltage)</b>	<p>High voltage is supplied to the electron gun section and the ion pump section of this electron tube.</p> <p>(1) The main body (body terminal) of this electron tube is used as the circuit return wire (ground wire). Securely connect it with the circuit return wire (ground) of the equipment together with the electromagnet stand or oil tank to ensure proper grounding.</p> <p>(2) Place a cover or cage around the high-voltage section to prevent it from being touched. The circuit must be designed so that a switch on the door cuts off high voltage and discharges the capacitor of the high-voltage section when the cover or cage is opened.</p> <p>(3) Before replacing or performing maintenance work on the electron tube, be sure to turn OFF the power switch and discharge all residual charge by touching each electrode of the electron tube with a ground rod. Pay particular attention to the charge in the capacitor of the high-voltage section. Never disable the door switch when the cage is open. At least two workers are required for replacement or maintenance work to ensure safety. (A person who has received training in cardiopulmonary resuscitation should be present.)</p> <p>(4) When connecting / disconnecting the ion pump, be sure to turn OFF the ion pump power supply and confirm safety.</p>
 <b>DANGER</b>	



 <p><b>(Electromagnetic radiation)</b></p>	<p>Observe the following precautions to prevent exposure to harmful high-frequency electromagnetic radiation (in particular, to avoid the risk of eye damage) and to prevent telecommunication devices from being adversely affected:</p> <ol style="list-style-type: none"> <li>(1) Never supply high voltage when the high-frequency load (output waveguide) is not connected to the high-frequency output section.</li> <li>(2) To prevent high-frequency leakage due to connection failure in the high-frequency output section and the high-frequency load, securely connect the coaxial tube, the waveguide, and the shield cover.</li> <li>(3) Do not modify or remove the high-frequency contact elements such as the gasket of the cavity/output section, the finger, etc. of the electron tube. If an electromagnetic shield is mounted, do not remove or modify it.</li> <li>(4) Evaluation of electromagnetic radiation leakage must be performed with the electron tube and the high-frequency load mounted in the equipment.</li> </ol>
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	WARNING
 <p><b>(X-ray irradiation)</b></p>	<p>An electron tube with a tube voltage of more than 10 kV will generate X-rays. X-ray generation increases as the voltage and current are increased.</p> <ol style="list-style-type: none"> <li>(1) Perform thorough evaluation for X-ray leakage for the equipment used in combination with this electron tube. Add shielding appropriate for the installation and operating conditions as required. Checks for X-ray generation must be performed both when high-frequency output operation is performed and when it is not performed.</li> <li>(2) If an X-ray shield is already mounted, do not remove or modify it.</li> <li>(3) Since the amount of X-ray generation may change over time, perform X-ray checks periodically.</li> </ol>
 <p><b>(Magnetic field)</b></p>	<p>About 0.05-tesla intense magnetic field and 0.13-tesla intense magnetic field are used for this electron tube.</p> <ol style="list-style-type: none"> <li>(1) Persons with cardiac pacemakers must not engage in the handling, operation, or maintenance of this electron tube.</li> <li>(2) The magnetic field of the electromagnet has been precisely adjusted. Do not allow any permanent magnets or magnetic objects to come near the electron tube or electromagnet. They will be attracted by the magnetic field, possibly resulting in personal injury or damage to the electron tube.</li> <li>(3) Do not place magnetic cards, floppy disks, etc. near the electron tube.</li> </ol>
	CAUTION

 <b>(Handling)</b>	<p>Only qualified engineers or persons who have received the specialized training listed below are permitted to handle this electron tube.  The types of specialized training required are as follows:</p> <p>(1) High-voltage work                      (4) Sliding work  (2) X-ray work                                (5) Crane operation  (3) High-frequency work                  (6) Electrical device work</p> <p>Read the operation manual carefully and fully understand the contents before handling the electron tube.</p>
 <b>(Temperature, Heat)</b>	<p>The following sections of the electron tube become very hot during operation: Collector enclosure, Electron gun section, Waveguide, Electromagnet.</p> <p>(1) Do not touch any of the sections listed above during operation or immediately after operation. (After operation is stopped, the above parts will remain hot for a while.) The high temperature of these sections may cause a burn.  (2) In tubes with evaporative cooling, the cooling water in the cooling-water tank is very hot, reaching temperatures near 100 degree C. Be extremely careful when handling it. Before disconnecting tubing, confirm that the cooling water has cooled sufficiently.</p>
 <b>(Weight)</b>	<p>Be careful when handling this electron tube because it is very heavy. (2900kg)</p> <p>(1) Be extremely careful to ensure safety when lifting, moving, or installing this electron tube.  (2) Be careful not to subject this electron tube to excessive vibration or shock because it is a precision device.  (3) Use the Toshiba Electron Tubes &amp; Devices Co., Ltd. standard packing box to carry or store the electron tube.</p>
 <b>(Caution)</b>	<p>Use the frequency specified by laws, regulations, or standards.</p>
 <b>(Caution)</b>	<p>Before operating this electron tube, confirm that the cooling unit operates Normally.</p> <p>(1) Excessive temperatures due to interruption of cooling air or water may result in damage to the tube, smoking, or a fire.  (2) It is recommended that various sensors such as an airflow sensor, a water flow sensor, a pressure sensor, a thermometer, and/or a smoke sensor be provided to protect the tube.</p>

	CAUTION
 <b>(Caution)</b>	<p>Note the following when handling damaged or used electron tubes:</p> <ol style="list-style-type: none"> <li>(1) When handling a tube that has fractured, wear protective gloves, protective glasses, etc. because the ceramic or metal fragments are sharp and very dangerous.</li> <li>(2) In order to protect the environment, used electron tubes must be disposed by specialized waste disposal personnel for recycling. Toshiba Electron Tubes &amp; Devices Co., Ltd.(TETD) will assist in the disposal of used electron tubes at no charge. Please contact TETD to make suitable arrangements. Note that TETD will not be held responsible for arrangements and costs prior to arrival at TETD.</li> <li>(3) The main materials used in this electron tube are as follows: Copper, stainless steel, iron, nickel/iron alloy, tungsten, molybdenum, ceramics, lead. Note that no radioisotopes or beryllia porcelain are used.</li> <li>(4) Lead is used for the X-ray shield of this electron tube. Do not abrade or melt the lead because lead powder or vapor is harmful if it comes into contact with the skin or is ingested. For lead disposal, consult with a specialized disposal personnel.</li> </ol>
 <b>(Caution)</b>	<p>Perform periodic inspection.</p> <ol style="list-style-type: none"> <li>(1) Dust from the air may build up on the electron gun section or collector section over time, leading to deterioration of withstand-voltage characteristics and interfering with cooling.</li> </ol>

\* Some of the operating precautions described in this manual are quoted from EIAJ EDR-1101 of Electronic Industries Association of Japan.

**For further information, Please contact Toshiba at following address.**

**TOSHIBA ELECTRON TUBES & DEVICES CO., LTD**  
**1385 Shimoishigami, Ohtawara-city**  
**Tochigi-ken, 324-8550 Japan**  
**Phone: +81-287-26-6345 Fax: +81-287-26-6060**